

# What is Reanalysis for?

Huug van den Dool

5/4/2015

Reanalysis workshop @ NCEP

## Spontaneous opinion of two luminaries:

Hua-Lu Pan:

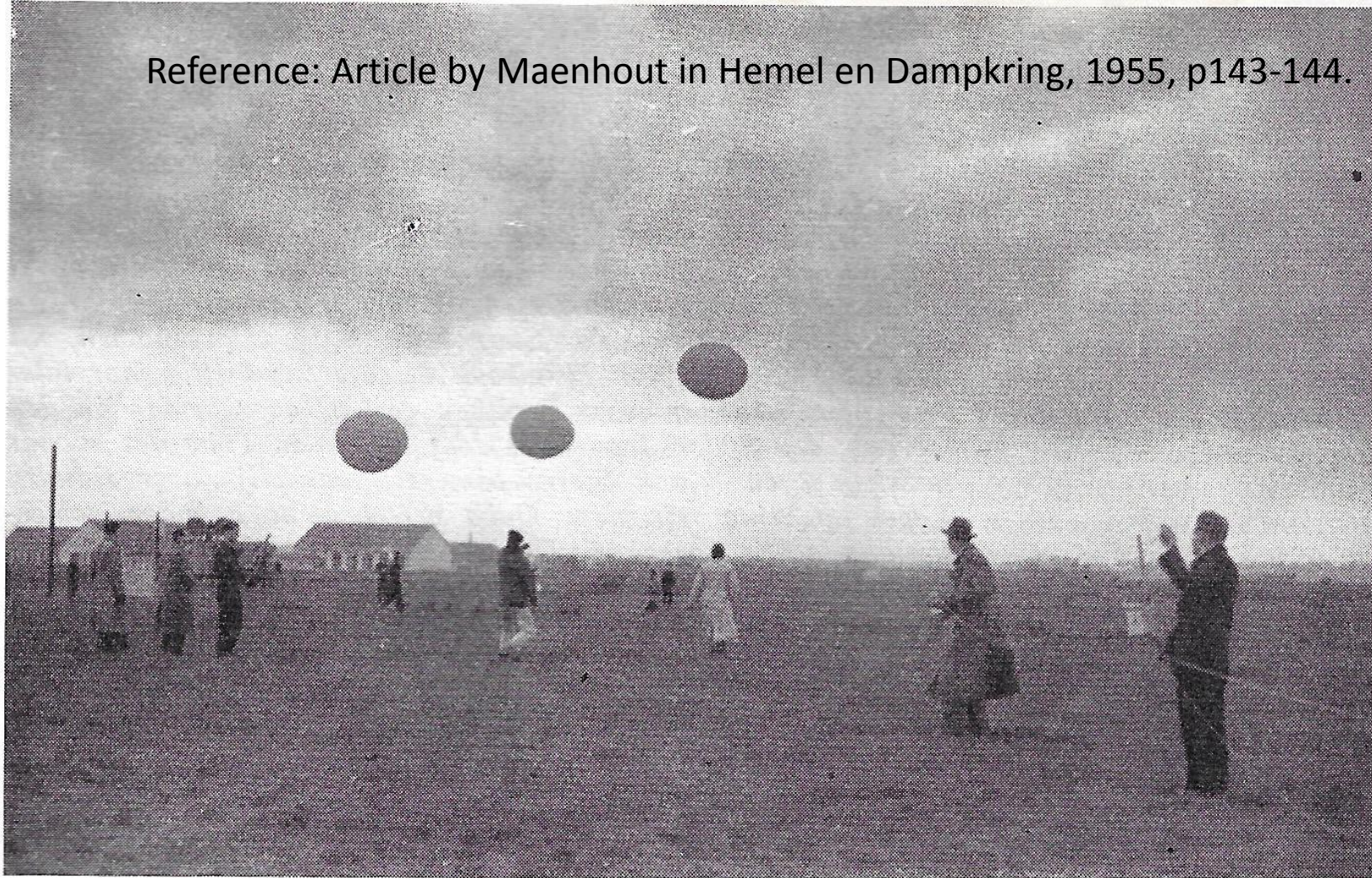
To do reanalysis is to provide the best initial conditions for the reforecasts.  
That is the only way we, at NCEP, can justify the effort.  
(Others are able to get funding to do Reanalysis but NCEP always had to do it out of hide.)

Bob Kistler:

Reanalysis extracts the maximum information from past years.  
Present day data assimilation systems are better than those run previously  
(with higher resolution and more complete physics  
and more optimal statistics for assimilating observations.)  
They also can assimilate obs that were either reduced in volume  
or avoided altogether (satellite , radar, etc).

One simple measure of that progress is the ability to make more accurate forecasts  
than either run originally or by previous reanalyses.

Reference: Article by Maenhout in Hemel en Dampkring, 1955, p143-144.



EEN TREIN SONDES WORDT BIJ EVERE OPGELATEN

*Het oplaten van de „trein” bij matige wind. Van links naar rechts ziet men de drie ballons, de Engelse, de Duitse en de Nederlandse sonde.*

**Malet, L. M., 1954: Diverses expériences de comparaison de radiosondes,  
Organisation Météorologique Mondiale, Genève, Note Technique  
No. 5. [R]**

# Vergelijking van radiosondes

Om tot een homogeen aerologisch net te komen is het absoluut noodzakelijk dat de verschillende instrumenten voor het meten van de druk, temperatuur en vochtigheidsgraad in de hoge luchtlagen met elkaar vergeleken worden. Bedenkt men daarbij dat er in West-Europa een tiental verschillende soorten sondes voor deze metingen gebruikt worden, dan is het duidelijk dat er af en toe internationale vergelijkingen moeten plaats grijpen.

Een eerste experiment in die zin werd in Mei 1950 gedaan te Payerne (Zwitserland) en nu werd in November 1954 te Evere (België) een nieuwe reeks vergelijkende peilingen uitgevoerd onder leiding van Dr L. Malet van het K.M.I. te Ukkel met medewerking van het K.N.M.I., de Deutscher Wetterdienst, de U.S. Air Force, de Belgische Luchtmacht en de Regie der Luchtwegen. Er werden tijdens een dertigtal opstijgingen bij dag en bij nacht vijf soorten radiosondes getoetst, namelijk de Kew MK2 (Engels), Bendix en AMT 4 (U.S.A.), Grow H 50 (Duits) alsmede de onlangs ontworpen K.N.M.I.-Philips sonde. Deze vijf sondes en een radar doel (corner reflector) werden tot een trein van ongeveer zeventig meter lengte verenigd en door drie ballons met een snelheid van 300 à 400 m/min tot in de hogere luchtlagen gevoerd. Door de medewerking van de USAAF was het mogelijk deze sondes ook te vergelijken met de US-Drop sonde, uitgeworpen door een B 29 die tevens de hoogte van de standaard niveauvlakken bepaalde.

Voor de berekening van de hoogte, de windsnelheid en de windrichting werden verschillende radar sets gebruikt die aldus ook onderling met elkaar vergeleken werden. Zo werden o.a. te Evere gebruikt: een set 584, een set GL 3, 2 radiotheodolieten GMD en een radiotheodoliet Metox. En wanneer het weder het toeliet werden de ballons ook met twee optische theodolieten gevolgd.

Uit dit alles blijkt wel dat er te Evere veel waarnemingsmateriaal verzameld werd. Nu is men druk aan het rekenen, zodat binnenkort de verschillende statistische uitslagen, die de voor- en nadelen van de verschillende sondes aantonen, zullen gepubliceerd worden. Daar er in Frankrijk ook aan een nieuw soort radiosonde gewerkt wordt, zal deze, zodra ze klaar is, vergeleken worden met de Kew MK 2 die aldus de schakel zal vormen met de nu onderzochte soorten, zodat binnen afzienbare tijd de meteorologische diensten beter zullen ingelicht zijn over de systematische afwijkingen in de aerologische gegevens van het West-Europese net.

A. MAENHOUT

My own personal slow warming to re-analysis as concept.

Remember the MIT school of V.P. Starr  
about General Circulation Statistics ?

Working with station data!!!!!!!!!!!!

# Atmospheric Circulation Statistics

ABRAHAM H. OORT AND EUGENE M. RASMUSSEN  
*Environmental Research Laboratories  
 Geophysical Fluid Dynamics Laboratory  
 Princeton, N.J.*

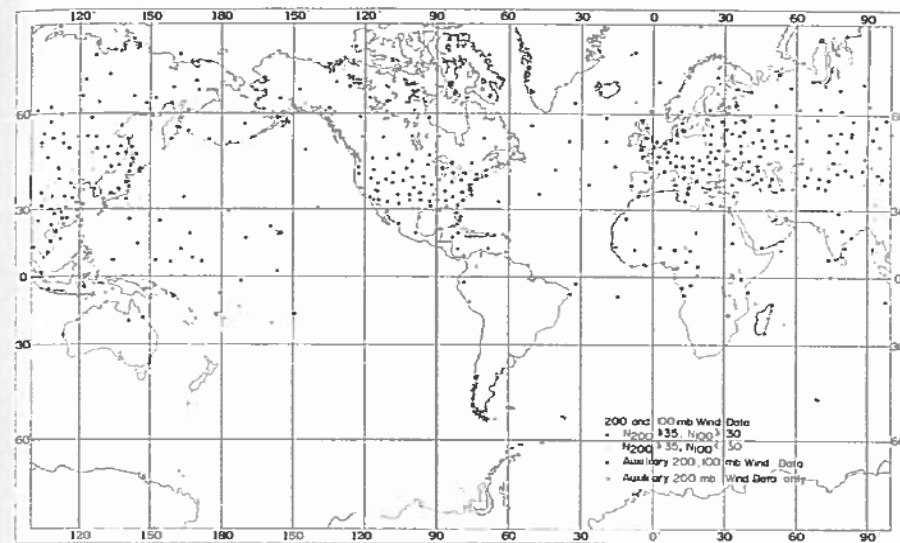


FIGURE 1b.—Map of the location of stations used for analysis at 200 mb; the symbol explanation is given on the map itself.

ATMOSPHERIC SCIENCES  
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JUN 7 1972

N.O.A.A.  
U. S. Dept. of Commerce

The bible in Meteorology for some time.  
 Out of the V.P.Starr school.



U.S. DEPARTMENT OF COMMERCE, Maurice H. Stans, *Secretary*  
 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, Robert M. White, *Administrator*

Rockville, Md., September 1971

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All zonally "averaged"

My impression (1973): Convenience of a gridded analysis trumps other considerations.

Starr/ Oort tradition was superseded by NCAR (Wallace et al.) use of old NMC grids

Maurice L. Blackmon, John M. Wallace, Ngar-Cheung Lau, and Steven L. Mullen, 1977: An Observational Study of the Northern Hemisphere Wintertime Circulation. *J. Atmos. Sci.*, **34**, 1040–1053.

doi: [http://dx.doi.org/10.1175/1520-0469\(1977\)034<1040:AOSOTN>2.0.CO;2](http://dx.doi.org/10.1175/1520-0469(1977)034<1040:AOSOTN>2.0.CO;2)

Reactionary Nightmare: Gridded data is true enough to an ignorant outside user (even if based on nothing) ?

The Climate Diagnostics Data Base (CDDDB) at CPC.

(1980 Rasmusson, Arkin, monthly gridded NMC analyses)

The changes due upgrades in model/analysis were very evident in CDDDB.  
Nevertheless....

People at CPC (a minority) had to be convinced that Reanalysis would improve upon CDDDB.

# In late 1982 I attended a brief course in objective analysis by Ron McPherson at NMC

He explained:

- What is an analysis (numbers on a grid)
- What do we need an analysis for? (to do calculations on that grid, conveniently)
- The analysis method (OI, Cressman...) is able to handle the day-to-day changes in input data.

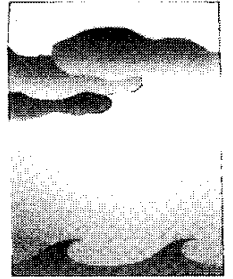
# Intermezzo: Station based diagnostics lives on (Relics of the past???)

- Michael Schindelegger and Richard D. Ray, 2014: Surface Pressure Tide Climatologies Deduced from a Quality-Controlled Network of Barometric Observations. *Mon. Wea. Rev.*, **142**, 4872–4889.  
doi: <http://dx.doi.org/10.1175/MWR-D-14-00217.1>
- CPC maintains the Climate Anomaly Monitoring System. It looks like an analysis, but it isn't. (Well, depending on how 'analysis' is defined.) Ropelewski, C. F., J. E. Janowiak, and M. S. Halpert, 1984: The Climate Anomaly Monitoring System (CAMS), Climate Analysis Center, NWS, NOAA, Washington DC, 39pp. [Available from the Climate Prediction Center, Camp Springs, MD 20746].

# *Reanalysis is a huge success*

- Success has many fathers (should I mention mothers in this case)
- Lots of credit has been given (order  $\sim 10,000$  citations)

# The NCEP/NCAR 40-Year Reanalysis Project



E. Kalnay,\* M. Kanamitsu,\* R. Kistler,\* W. Collins,\* D. Deaven,\* L. Gandin,\*  
M. Iredell,\* S. Saha,\* G. White,\* J. Woollen,\* Y. Zhu,\* M. Chelliah,+ W. Ebisuzaki,+  
W. Higgins,+ J. Janowiak,+ K. C. Mo,+ C. Ropelewski,+ J. Wang,+  
A. Leetmaa,\* R. Reynolds,\* Roy Jenne,# and Dennis Joseph#

assimilating these data with a data assimilation system that is kept unchanged over the reanalysis period 1957–96. This eliminates perceived climate jumps associated with changes in the data assimilation system.

(Insightful lines from the abstract:)

DA with a constant system, yes, wonderful

Eliminates some fictitious climate change, yes, but we are not there yet

The challenge continues,

-) in terms of DA method, and in terms of

-) use of the ever changing data in an ever changing environment.

# What is Reanalysis for?

- To produce a: the best General Circulation Statistics, b: the best **short**-term climate diagnostics and monitoring, and c: the best **long**-term climate diagnostics and monitoring
- To create the best initial states for Retrospective Forecasts (thus allowing enough hindcasts)
- To make better use of all observations ever taken
- To use observations never used before (impetus for mining)
- To study and interpret historically important events, usually extremes.

Oh, don't forget mission creep, moving goal posts etc

# To study and interpret historically important events, usually extremes,

- 1953 flood (R1, forecast included)
- 1894/1897 floods (20<sup>th</sup> century Reanal, no forecasts)
- 1871 fires in the mid-west (20<sup>th</sup> century Reanal, no forecasts)
- -----
- The all time record high temperature (38.6°C, 1944) in the backyard of Dr Thate at Warnsveld in The Netherlands. Mesoscale model (50 m resolution) with 20CR boundary conditions plus incredibly detailed lower boundary conditions (re land use, energy production)

# Random thoughts on accuracy of Reanalysis

- My opinion: “Accuracy” is not spelled out properly as requirement in Reanalyses (contextual)
- Apparently, accuracy is not all important because R1 is STILL widely used for ‘monitoring and diagnostics’
- P.A. Bergsma went to Indonesia in 1860 (to found the Meteorological&Magnetic Observatorium in Batavia/Djakarta) claiming a 0.02mm Hg accuracy in reading hourly pressure. Today these obs make it into Reanalysis with an assumed obs error of close to 1hPa.
- F.H. Schmidt (@ KNMI 1937-1977) gave a speech when he retired noting that accuracy of observing was much better in the past. His example was the meteorograph on a small plane (going up in circles to 5, sometimes, 6km weather permitting) in comparison to a radiosonde. (radio-sonde to satellite ????)

# In the end...

- Reanalysis is about analysis.
- Blessing and curse: NWP like technology for Reanalysis
- Is there any room for a Climate Reanalysis. How would this differ?
- How dead is 'analysis' of <...you name it..> based on station data only

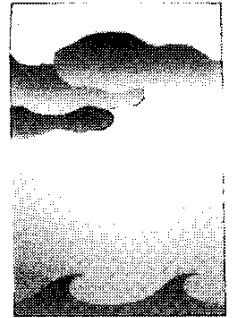
# Homogeneous Analyses

## desirable yes, but possible???

- Opinions in CPC about R1. A huge success but.....
- Reanalysis of 20<sup>th</sup> century is an attempt to create a homogeneous Reanalysis (accuracy is 2ndary) by thinning out the data to .... <....> . How successful???
- C.R. Ferguson and G. Villarini, 2014: An evaluation of the statistical homogeneity of the 20CR. Climate Dynamics, 42, 2841-2866. (One might be ALARMED reading this). Increasing number of surface pressure obs over US was a source of inhomogeneity.
- My sense: Hindcasts and their use for calibration in real time have added a new and different urgency to the need for homogeneous Re-analysis. How do we balance accuracy and homogeneity.? Perhaps we don't.

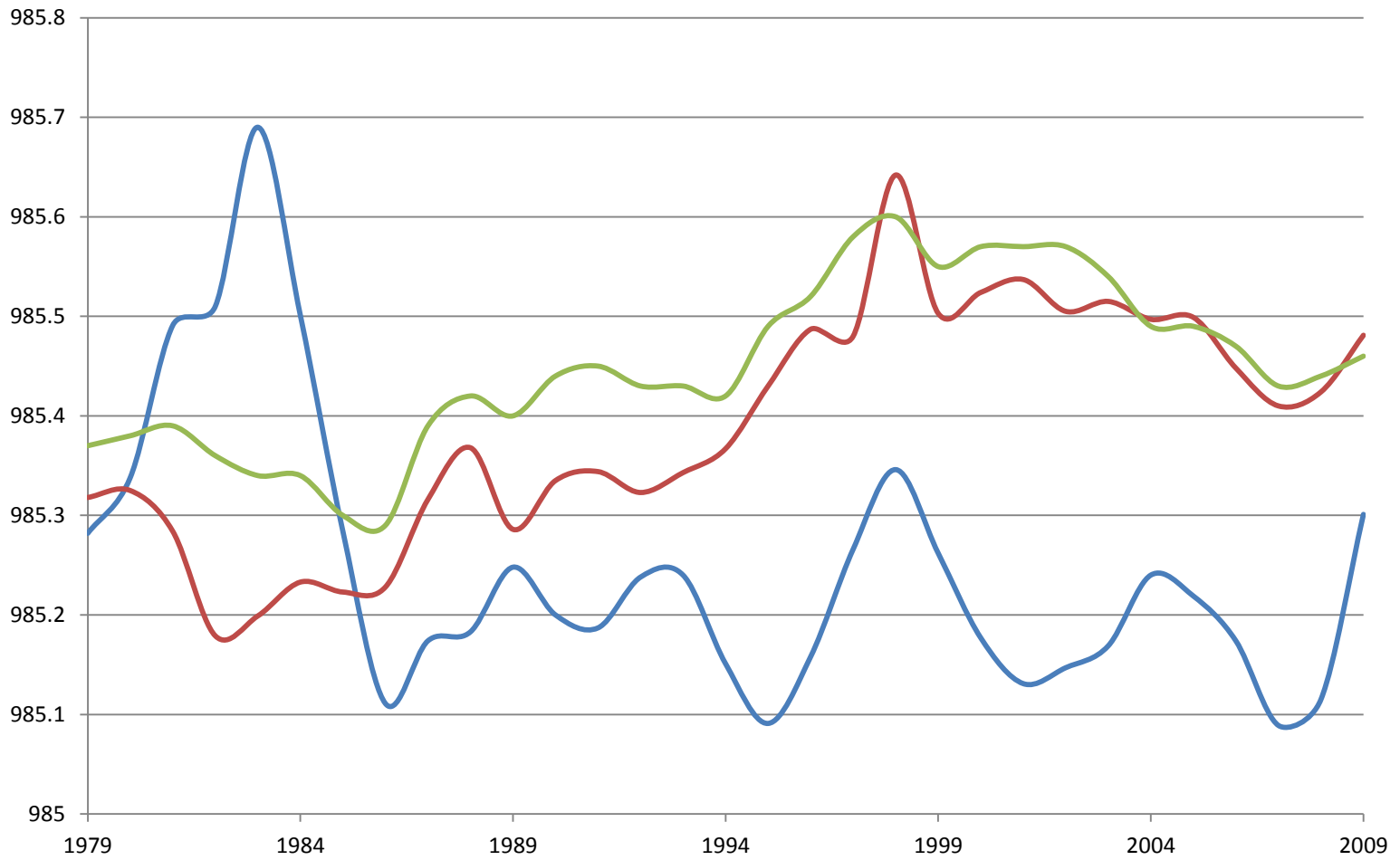
Thank You

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CR20  
CFSR  
ECMWF